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Green Ash Seed Sources for North Dakota

James L. Van Deusen and Richard A. Cunningham

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James L. Van Deusen, Research Forester
Rocky Mountain Forest and Range Experiment Station[1]
and
Richard A. Cunningham, Research Geneticist
Agricultural Research Service, USDA
Northern Great Plains Research Center[2]

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Based on survival and height after eight field seasons, seed from the following provenances is recommended for use in growing planting stock for use in North Dakota: Aten, Nebr., Gettysburg, S. Dak.; Faith, S. Dak.; Lisco, Nebr.; Beaver Crossing, Nebr.; Belfield, N. Dak.; Prairie City, S. Dak.; Bismarck, N. Dak.; and Redfield, S. Dak.

Keywords: *Fraxinus pennsylvanica*, provenance test, Great Plains.

[1]*Headquarters is in Fort Collins, in cooperation with Colorado State University. Research reported here was conducted at the Station's Research Work Unit at Bottineau, N. Dak., in cooperation with North Dakota State University, Bottineau Branch.*

[2]*Mandan, N. Dak.*

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Management Implications

Of the provenances tested, NE 14 and SD 10 are probably the best choices from which to collect seeds for green ash planting stock for North Dakota. Ying and Bagley (1976) also recommend provenance NE 14 because it produced progeny that grow faster than average in six out of seven plantations. Seven other provenances are also recommended because of their good growth; SD 7, NE 15, NE 16, ND 1, SD 8, ND 6, and SD 11. The nine recommended provenances comprise the fast and medium growth clusters identified by ISODATA analysis, based on height and diameter growth. These nine provenances also overcome a possible local limitation on seed availability in that green ash seed should be available somewhere in the recommended provenances every year.

Collections from SD 10 should be made from the original shelterbelt, and probably the tree, which supplied seeds for this study. Seeds from other recommended provenances should come from native trees. Copies of the original seed collection record forms are on file at the USDA Forest Service Shelterbelt Laboratory in Bottineau, N. Dak. Based on current knowledge of seed zones, we recommend zones 1060, 1022, 532, 533, 542, 553, 584, 630, and 651 (Cunningham 1975). Seed collections from provenances ND 4, ND 2, SD 9, ND 3, and SD 12 probably should be avoided because of relatively slow growth.

Introduction

Green ash (*Fraxinus pennsylvanica* Marsh.) is a moderately fast growing, deciduous, hardwood tree that is being planted in large numbers in North Dakota for field shelterbelts, farmstead windbreaks, wildlife plantings, urban parks, and recreation areas. Survival of green ash has been outstanding on practically all sites throughout the Great Plains. Read (1958) reported that a survey of Great Plains shelterbelts in 1954 revealed overall survival of green ash averaged 77% at age 16. In North Dakota plantings, green ash survived best (88%) on deep, permeable, well-drained loams along river lowlands and stream valleys—sites similar to those on which it grows naturally. Read (1958) suggested that green ash is probably one of the best medium to slow growing windbreak species from the standpoint of survival and adaptability.

Green ash is the most widely distributed of all the American ashes (Wright 1965). Its range extends from Cape Breton Island and Nova Scotia to southeastern Alberta and Montana, and southward to central Texas and northern Florida (fig. 1). At least three different green ash ecotypes have been identified in the Great Plains (Mueli and Shirley 1937): The population from the arid northwestern part of the Great Plains is more drought resistant than that from the north-central Great Plains, which is more drought resistant than that from the south-central Great Plains. This is in line with annual rainfall in the Great Plains, which tends to increase in amount from north to south. Mueli and Shirley also found that parent trees and their progeny decreased markedly in size from south to north; the same size decrease is evident from east to west. Other provenance studies have shown pronounced ecotypic differences in susceptibility to low winter temperatures (Wright 1944). When grown in central Massachusetts, trees from the southern part of the range grew vigorously during the summer but winter-killed back nearly to the ground. The northern trees were slower growing but hardy.

Figure 1.—Distribution of native green ash (distribution map from Little, 1971).

A provenance study of green ash (Bagley 1970) utilizing seed collections from nine locations in the Great Plains showed that excellent growth could be obtained by planting seed from a green ash provenance as much as three degrees latitude north of its native site. When grown south of their native origins trees from northern provenances grew more slowly than did trees from local sources. Trees from Nebraska sources generally grew faster in North Dakota and South Dakota than trees from fifteen other Great Plains provenances (Ying and Bagley 1976).

On northern sites, the growth advantage of trees from southern provenances over trees from northern provenances may result from their ability to take advantage of the increased length of the day during the growing season. However, northern latitudes pose the threat of early freezes, extreme winter cold, or other climatic pressures to which the trees may not be adapted.

The most consistent long-term success in selecting seed sources that exhibit desirable growth, form, and survival should be achieved by using seed sources that have performed well in provenance tests conducted on sites similar to those on which most of the planting will take place.

Methods

In 1971, green ash seedlings from 19 provenances were shipped as 1+0 stock to Bottineau, N. Dak. (fig. 2 and table 1). They were supplied by Walter T. Bagley, Associate Professor, Department of Horticulture and Forestry, University of Nebraska, Lincoln, who furnished planting stock for three Nebraska plantations and to three of his out-of-state cooperators. The seeds were collected in 1968 and 1969 from as few as one and as many as ten native trees in each provenance, except the collections from SD 10 and ND 2, which were made from a single planted tree at each location. Seed trees were average or better when compared to other green ash trees near them. They had not been infested by insects or diseases, and their crowns were full and normal. Seedlots were labeled and stored separately, but the seedlings shipped to Bottineau were not identified more precisely than by provenance number.

The seedlings were too small for field planting in the spring of 1971. They were held an additional year in a transplant bed and planted by a Soil Conservation District crew May 18, 1972, on the Robert Surdahl farm 19 miles west of Bottineau.

Study area and design

The study, planned in consultation with the landowner, consisted of two single rows of trees (single row shelterbelts) oriented generally east-west. The rows are 900 feet (274 m) apart and have been separated in alternate years by grain crops and summer fallow. The soils at the test site are characterized as deep, nearly level, and moderately well drained. They are medium and moderately fine textured soils on glacial lake plains. They are high in organic matter, have high

Table 1.—Geographic locations of seed sources in the green ash provenance study at Bottineau, N. Dak.

State	Provenance	Nearest town	Latitude	Longitude	Seed zone[1]
			°North	*°West*	
North Dakota	ND 1	Belfield	46°45′	103°00′	542
	ND 2	Carson	46°30′	101°30′	542
	ND 3	Warwick	47°45′	98°45′	551
	ND 4	Fingal	46°45′	97°45′	552
	ND 5	Mandan	46°45′	101°00′	542
	ND 6	Bismarck	46°45′	100°45′	532
South Dakota	SD 7	Faith	44°45′	102°00′	630
	SD 8	Prairie City	45°30′	103°00′	584
	SD 9	Timber Lake	45°15′	101°00′	630
	SD 10	Gettysburg	44°45′	100°00′	533
	SD 11	Redfield	44°45′	98°45′	553
	SD 12	Dempster	44°30′	97°00′	1021
Nebraska	NE 14	Aten	42°30′	97°30′	1022
	NE 15	Lisco	41°00′	103°00′	651
	NE 16	Beaver Crossing	40°30′	97°15′	1060
	NE 17	Louisville	41°00′	96°15′	751
	NE 18	Hickman	40°30′	96°45′	1060
Kansas	KS 20	Haverhill	37°30′	96°45′	762
Oklahoma	OK 22	Unger	35°45′	95°45′	840

[1] *Cunningham (1975).*

Figure 2.—Locations of green ash seed collections and the North Dakota test site.

available water capacity, with moderate to slow permeability.

Elevation at the study area is about 457 m. Average annual precipitation on this site is about 16 inches (41 cm), with May through September totals averaging about 11.5 inches (29 cm).

The 19 provenances were planted in 4-tree plots randomly located within each of eight replications. Trees within rows are placed 8 feet (2.4 m) apart. Row 1 contains replications 1 through 4, while row 2 is made up of replications 5 through 8. Replication 8 contains only 12 provenances because of a shortage of trees from some provenances.

The trees have received no special cultural care since they were planted. Grain cropping and summer fallow have minimized weed and grass competition adjacent to the rows, but competition within rows has not been treated. None of the trees have been pruned, and multiple stems are common (fig. 3).

Results and Discussion

Survival

This is the most important factor to be considered when testing trees for adaptability to the severe climate of the northern Great Plains. Survival of trees from all central and northern provenances was 88% or better (table 2). All Oklahoma trees were dead by 1973, and only two Kansas trees were alive after 1975. Survival of trees from Oklahoma and Kansas was not analyzed. Most of the mortality could be attributed to the severe North Dakota winters. Excluding the Oklahoma and Kansas provenances, there was little variation in survival among the remaining 17 provenances.

Height

The 17 provenances were divided into fast, medium and slow growing groups by means of an ISODATA cluster analysis, using the combined height and diameter data for 1979. After the ISODATA analysis, additional tests were made comparing the three groups

Figure 3.—Multiple stem growth on a 10-year-old green ash.

Table 2.—Means of selected characteristics of trees from 19 Great Plains provenances of green ash after eight field seasons

Provenance	Height	Diameter at 1.5 m	Survival	Multistemed trees
	m	*cm*	*percent*	
NE 14	3.95	4.61	100	71
SD 10[a]	3.93	4.74	97	67
SD 7	3.58	4.51	100	57
NE 15	3.56	4.20	100	74
NE 16	3.55	4.34	88	79
ND 1	3.54	4.40	100	62
SD 8	3.51	4.37	100	44
ND 6	3.50	4.55	96	85
SD 11	3.45	4.25	97	53
ND 5	3.38	3.93	100	41
NE 17	3.37	3.81	100	91
NE 18	3.36	3.80	94	90
ND 4	3.26	3.49	100	48
ND 2[a]	3.23	3.64	97	48
SD 9	3.15	3.68	97	43
ND 3	3.01	3.92	100	70
SD 12	2.93	3.26	100	60
KS 20	3.60[b]	–	7[b]	–
OK 22	0	0	0	0

[a]*A single planted tree.*
[b]*Only 2 out of 30 trees were alive after 3 years. These data were not analyzed.*

in a stepwise manner using the S-method (Sheffe, 1959) of judging all contrasts. These analyses showed the three groups are statistically different ($p < 0.05$), but the differences among individual provenances at the border between the medium and slow growing groups are not distinct.

The three clusters maintained their relative positions throughout the eight field seasons (fig. 4). The fast growing group consisted of NE 14 and SD 10. The medium group was made up of SD 7, NE 15, NE 16, ND 1, SD 8, ND 6, and SD 11. The slowest group was ND 5, NE 17, NE 18, ND 4, ND 2, SD 9, ND 3, and SD 12.

After eight field seasons, trees from the fast cluster had grown on average a little more than 1.2 times taller than trees from the slow cluster. The height difference between one of the tallest provenances (NE 15) and an average provenance (NE 18) is shown in figure 5.

Diameter at Breast Height

D.b.h. and height are usually closely related in trees that are not growing in dense stands. So, it is expected that tall trees will have large diameters. This study produced a reasonably close relationship between height and diameter; the provenances that tend to be taller also tend to have large d.b.h. (table 2). D.b.h. data were not analyzed in this study except in combination with height for the ISODATA cluster analysis. As long as d.b.h. is large enough to provide adequate support for the tree crown, it is not a determining factor in recommending provenances. Another factor that may have affected d.b.h. of the trees is the number of major stems produced. D.b.h. of a tree with only one central stem generally will be larger than if the tree has produced several major stems.

Multiple Stems

All provenances had at least 40% of the trees with more than one stem originating below breast height (table 2). The nine provenances that seem best suited for North Dakota were about average, with 53% to 74% having multiple stems.

Apical dominance in opposite-leaved species such as green ash can easily be destroyed by many factors during the seedling stage and during subsequent development. If the terminal bud is killed through physical or environmental effects, and if thereafter both lateral buds develop, the tree is consequently forked. The process can continue in following years.

Winter-kill of terminal buds may cause multiple-stemmed trees. Top pruning in nursery beds may cause many trees to be forked. Browsing or breaking by animals may also cause multiple-stemmed trees. The evidence suggests that pruning lower branches often may be necessary to maintain a single stem. A multiple-stem characteristic also suggests that if potential

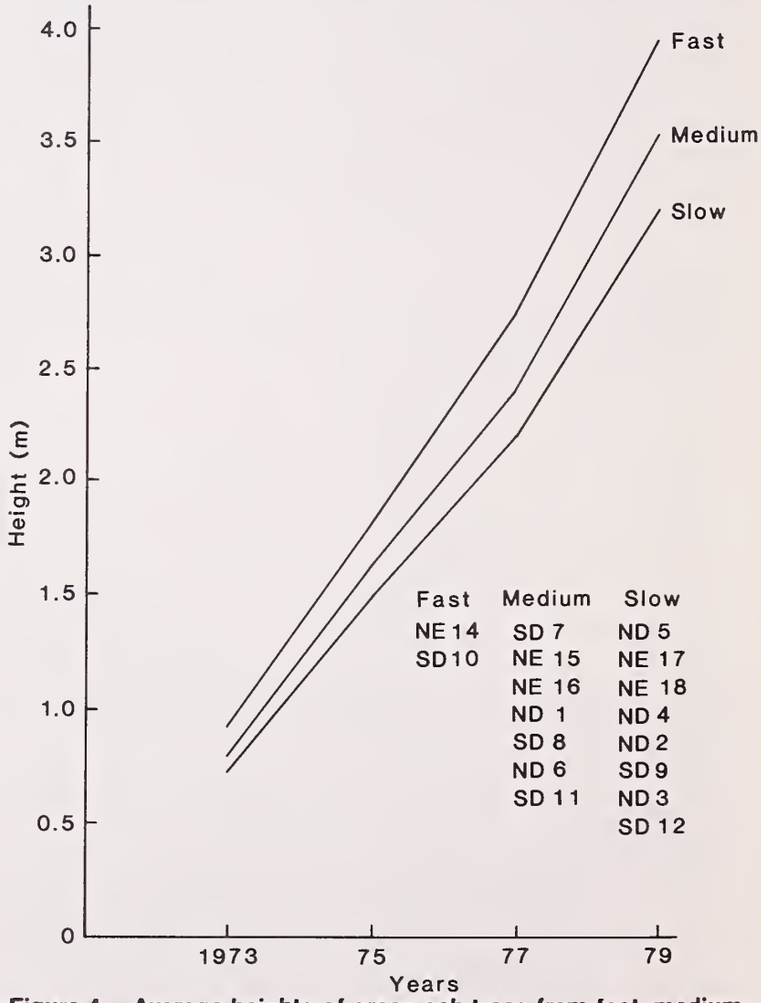

Figure 4.—Average heights of green ash trees from fast, medium, and slow growing provenances.

Figure 5.—The tree on the right (NE 15) compared with an average grower from provenance NE 18, after eight field seasons.

height and diameter growth are distributed among several stems, judicious pruning could strengthen the tendency toward height advantage shown by trees from recommended sources.

More of the trees from the Nebraska provenances had multiple stems. No observations were made on winter injury, but it is possible that terminal buds or newly emerging shoots on more trees from Nebraska provenances were killed by frost than on trees from other provenances. Deer and rodents have been seen in the area of the plantation. They could have influenced the multiple-stem characteristics, but there is no direct evidence for this.

Leaf Drop

Trees from North Dakota tended to drop their leaves earlier than did trees from Nebraska. Trees from South Dakota provenances tended to be midway between these two extremes (table 3). Ying, Schultz, and Bagley (1974) also found that leaves on trees of northern origin dropped earlier than those on trees of southern origin. Limited observations of leaf drop were made in a second year. These data are not included in this report, but they tend to reinforce the first year's trials.

Table 3.—Percent of green ash trees on which more than 50% of the leaves had dropped, by selected fall season dates, 1975

State	Trees	Date of observation				
		9/22	10/1	10/6	10/20	11/14
	number	*percent*				
North Dakota	181	22.6	65.2	97.8	100.0	–
South Dakota	168	13.7	52.4	94.6	100.0	–
Nebraska	149	0.0	17.4	74.5	99.3	100.0

Leaf drop data are necessarily subjective, but it was possible to detect a loss of approximately half the leaves from the crown. Leaf retention could be important, especially in widely spaced trees, where crown density must be maintained into the fall to prolong the soil and snow management benefits of the shelterbelt. Tree breakage caused by early fall snows that are heavy with moisture is seldom a problem in North Dakota. No data on bud break or leaf emergence were taken in the study.

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